

Design and Fabrication of Gravity Separator for Grains and Dust

Mr. S. Muruganantham¹, Mr. S. Jeeva², Mr. R. Gopalakrishnan³, Mr. S. Harikeswaran⁴, Mr. C. Jerin Dhas⁵

¹Assistant Professor, Mechanical Engineering, Nandha Engineering College, Erode, Tamilnadu, India.

^{2,3,4,5}UG, Mechanical Engineering, Nandha Engineering College, Erode, Tamilnadu, India.

Emails: muruganantham.somasundaram@nandhaengg.org¹, jeevajeeva5480@gmail.com², gopalsedapalayam@gmail.com³, rcmotorist302@gmail.com⁴, jenijerin4@gmail.com⁵

Abstract

Gravity separators are machines used to separate grains and dust by using the difference in weight between grains and dust. They work by causing grains to fall at different speeds, with heavier grains falling faster and lighter dust falling slower. The new gravity separator design is more efficient and effective than previous designs, making it easier to clean and maintain. It has the potential to revolutionize the separation process, saving businesses time and money. The new gravity separator is more effective at separating grains from dust and other impurities, improving the quality of food products and mined minerals. Additionally, it is also reducing waste.

Keywords: Gravity separators, Grains, Dust, Design, Testing

1. Introduction

The design and fabrication of a gravity separator for grains and dust offer an innovative method to improve efficiency and precision, reducing labor costs and human error, compared to traditional methods. This project proposes a gravity separator to improve grain and dust separation systems by optimizing airflow patterns and particle trajectories, minimizing energy consumption, and utilizing high-quality materials and precision manufacturing techniques for durability, reliability, and performance. The anticipated deployment of this gravity separator stands poised to revolutionize the grain processing sector.[1] Offering a streamlined and economical method for separating grain from dust, this separator promises to elevate grain quality, slash production expenses, and bolster ecological sustainability.

2. Experimental Methods or Methodology

An essential step in post-harvest processing involves purifying grain material from contaminants, which can comprise up to 15-20% of the harvested yield. Prompt post-harvest grain treatment enhances harvesting efficiency mitigates spoilage risks, and Preserves grain quality, with particular emphasis on

cleaning seed grain. The process of Separator is shown in Figure 1.

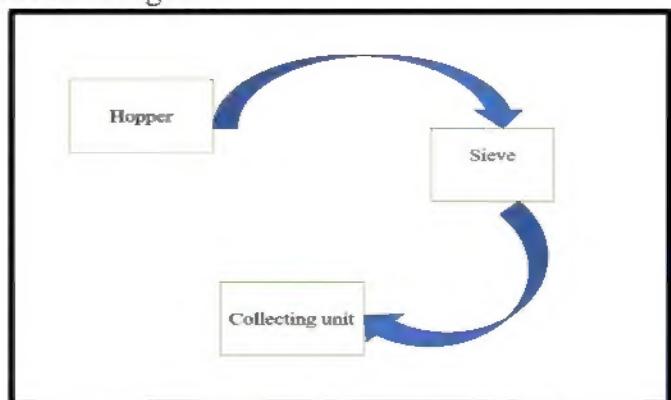


Figure 1 Process of Separator

3. Results and Discussion

3.1 Development of Gravity Separator for Agriculture

The project aims to create a solar-powered multi-crop cleaner tailored for small-scale and marginalized farmers [2]. This cleaner will boast a moderate capacity, adaptable screen system, minimal operational expenses, and straightforward maintenance and operation. The objective is to offer

a technology-driven solution suitable for addressing the degradation in quality, storage expenses, handling and transportation costs, as well as the risk of grain infestation. [3-4] There is a rising demand for superior food products, yet numerous traders continue to market substandard food grains laden with foreign contaminants such as stones, sand, leaves, and broken, and damaged seeds. This inferior-quality rice often goes unnoticed without any dedicated mechanism in place to detect such poor-quality grains, posing a challenge for both consumers and sellers alike. Image processing techniques for testing the quality of rice grains are inexpensive and less time-consuming. Farmers in India face challenges in cleaning grains because they cannot afford high-priced machinery. Grain cleaning machines vary in cost, typically priced between 65,000 and 100,000, depending on their

specifications and features. Furthermore, seed industries frequently cultivate seeds on farmers' fields without their consent, exploiting them by withholding rightful compensation. To mitigate such risks and prevent financial setbacks for farmers, a solar-powered pneumatic grain/seed cleaning system was engineered, incorporating specific functional, structural, and operational design parameters. This developed pneumatic cleaner underwent rigorous testing using garden pea, bottle gourd, sponge gourd, and radish seed lots with varying impurity levels, consistently achieving over 99% physical purity regardless of seed type or impurity levels. The system demonstrated a cleaning efficiency surpassing 96%, with throughput capacities of 80 kg/h for peas, 50 kg/h for bottle gourd, and 75 kg/h for radish, respectively.

3.2 2D-Layout

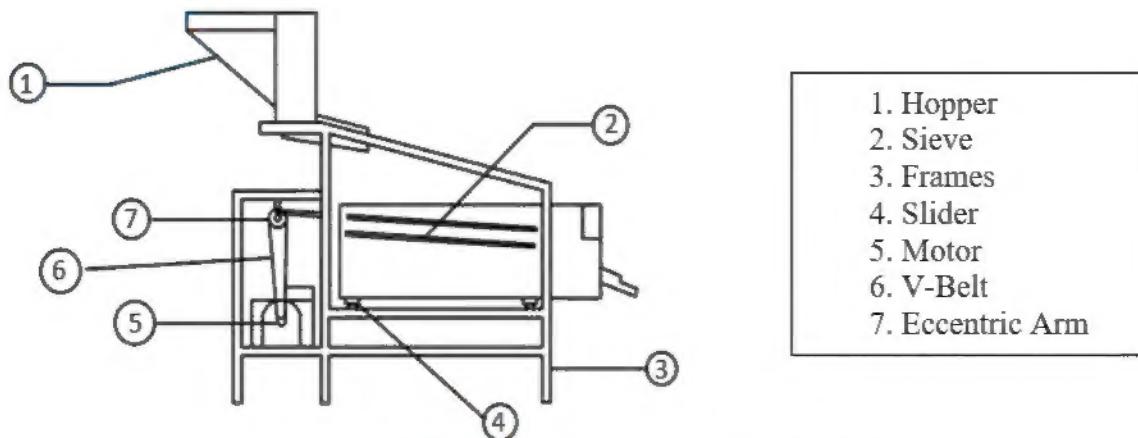


Figure 2 Layout and Components

4. Discussion

[5-6] The existing approach for eliminating chaff and other foreign substances from grains relies on manual labor, which proves to be both time-consuming and limited in capacity. Moreover, this method fails to yield grains of high quality. There is a need for a machine that can eliminate or reduce to the barest minimum all the limitations associated with the manual method of removing chaff and other foreign materials from grains. This machine should

be able to process a large quantity of grains in a short period, and it should produce high-quality grains. Utilizing solar energy as a renewable power source for a grain separator would diminish dependence on non-renewable energy sources and decrease operational costs. The project seeks to develop a solar-powered grain separator that is a workable and sustainable alternative for grain separation in the agriculture industry. [7-10] The cost analysis of manufacturing generators and electric motors. It also

emphasizes the importance of energy conversion and consumption in India's agriculture sector. The main goal of the project is to design and construct a gravity separator for soybean screening in agriculture. The factors that are examined include the pricing, availability, and mechanical qualities of the materials. The performance and efficiency of the machine are evaluated through experiments, considering factors like feed rate capacity and sieving efficiency. The document also delves into the advantages and disadvantages of pneumatic and hydraulic systems in industrial processes. It explains that both systems rely on pressure in a fluid, but hydraulic systems require a pressure regulator for control. The design of the sand sieve machine considers these characteristics. In summary, the document presents the entire process of designing, analyzing, and fabricating an automated sand filter and waste separator machine. It emphasizes the machine's efficiency, energy-saving aspects, and flexibility. The document concludes that the machine's design is environmentally friendly and has Advantages. Layout and Components are shown in Figure 2. The design phase focused on enhancing flow throughout the grain mixture and selecting an appropriate fan with ample volume flow to effectively separate impurities. The final pneumatic aspirator, produced as a result, achieved a remarkable efficiency rate of 95.9% under maximum aspiration conditions. Validating the aspirator concept involved simulations and various tests conducted on a prototype. This ultimately led to the development of a highly efficient pneumatic aspirator capable of effectively purging impurities from grain mixtures, meeting all specified criteria. This research addresses a gap in both literature and industry by exploring the design process for a compact horizontal crossflow grain aspirator, eliminating the need for interchangeable sieves and screens. The aspirator's adaptability to diverse configurations, achieved through macro and micro adjustments instead of sieves and dividers, was successfully demonstrated. Additionally, the paper presents experimental findings and efficiency

calculations for both adjusted and maximum aspiration scenarios. [11-13] the importance of understanding the geometry and physical phenomena of the separation process, such as the "lifting phenomenon," and the need to address the shortcomings of existing separators. They also discuss the motion of seeds inside the cylinder and the use of high-speed cameras and computer modeling to simulate seed trajectories. In addition, they reference related studies and papers in the field, including those discussing the evaluation of cylindrical cells, the motion of seeds within the cylinder, and the use of computer scanning and other technology for modeling seed-sorting devices. [14] They conclude by emphasizing the need for computerized control of separator parameters and the use of advanced technology for seed cloth separation.

4.1 Efficiency calculation

Efficiency (%) = (Amount of clean grain / Amount of grain fed into the separator) x 100

Amount of grain fed into the separator = 100 kg

Amount of clean grain = 80 kg

Waste = 20 kg

Efficiency (Paddy)= (80 kg / 100 kg) x 100 = 80%

Waste removal = 20%

Efficiency (Wheat)= (75 kg / 100 kg) x 100 =75%

Waste removal =15%

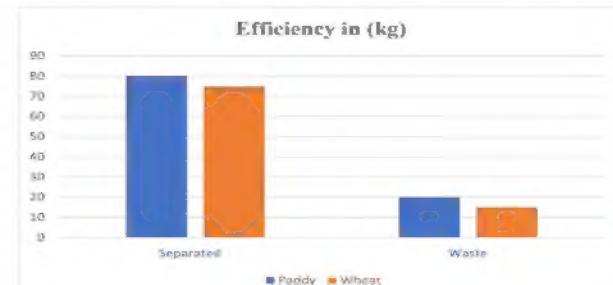


Figure 3 Efficiency

Conclusion

Different grains have varying properties, such as size, shape, and density, which can affect the separation process. Higher moisture content can make grains more susceptible to sticking and clinging to impurities, reducing separation

efficiency. [15] The type and number of impurities present in the grain can also impact separation efficiency. For instance, hard and dense impurities may be more challenging to remove than lightweight and easily separable ones. The design and settings of the grain separator, such as the size and spacing of sieves, air flow rate, and vibration intensity, play a significant role in determining the separation efficiency of the calculation shown in Figure 3.

References

[1] M.A. Begunov, V.S. Koval, A.V. Chernyakov “Study of a pneumatic separator for grain cleaning” E3S Web of Conferences 413, 01023 (2023)

[2] Pramod P Aradwad, Arun Kumar T V, J P Sinha, Rahul S Yadav “Screen cleaner for on-farm processing of grains” Indian Journal of Agricultural Sciences 91 (5): 695–8, May 2021

[3] Pravin S. Dahimiwal, Akash S. Deshmukh, Mangesh B. Ghanekar, Yashraj S. Bhosale “Design and Fabrication of Grain Grading and Polishing Machine” IARJSET Vol. 4, Issue 5, May 2017

[4] Alka Mishra, Jagannath Prasad Sinha “Development of solar powered pneumatic grain/seed cleaning system” Indian Journal of Agricultural Sciences 88 (11): 1676–81, November 2018

[5] Oladimeji A.O., Imoukhuede O.B. and Ayodele B.B. “Design and construction of a multipurpose air screen grain cleaner” International Journal of Applied Research 2020; 6(5): 204-207

[6] Vignesh Mardolkar, Sudhakar Haldankar, Aditya Kamate, Kailas Pathade “Design and fabrication of grain separator solar energy” IRJMETS Volume:05 May-2023

[7] Ankush P. Borkar, Aniket S. Shrawankar, Ashwin P.Nandanwar, Gaurav P. Meshram “Design and fabrication of gravity separator for soybean screening” IRJMETS Volume:03 Apr-2016.

[8] V. Chandramohan, T. Ragunath, S. Sanjith, G. Santhosh Vishnu, N. Vivek “Design and Fabrication of Automated Sand Filter and Waste Separator Machine” IJRASET Volume 9 Issue III Mar 2021

[9] Bashir, E. Musa and Momodu, O. Glory “Design and Fabrication of a Compact Single Acting Hammer Mill” Advances in Engineering Design Technology Vol. 2, 2020 pp. 80-88.

[10] A. M Giyevskiy, V I Orobinsky, A P Tarasenko, A V Chernyshov, and D O Kurilov “Substantiation of the basic scheme of grain cleaning machine for preparation of crops seeds” IOP Conf. Series: Materials Science and Engineering 327 (2018) 042035

[11] Elchyn Aliiev, Krystyna Lupko, “Prerequisites for the Creation of a Mechatronic System of Indented Cylinders for the Separation of Fine Seeds” Scientific Horizons, 24(3), 75-86 2021

[12] Ivan Rogovskii “Experimental study of the process of grain cleaning in a vibro-pneumatic resistant separator with passive weeder” Bulletin of the Transilvania University of Brașov Vol. 13(62) No. 1 – 2020

[13] E. S. Yayock, M. Isiaka “Design and Fabrication of a Multi-Grain Cleaning and Grading Machine” IJAEM Volume 2, Issue 9, pp: 430-441

[14] Prof. Anuj Muley, Khushal Waghmare, “Design and fabrication of pedal operated grain sieving machine for agriculture used” IRJMETS Volume:04 May -2022

[15] Paul Greyvensteyn1, Ockert Koekemoer “Design and Testing of a Pneumatic Grain Aspirator for Efficient Separation of Impurities” Proceedings of the 9th World Congress on Mechanical, Chemical, and Material Engineering (MCM'23) ICMIE 141 August 06-08, 2023.